CHAPTER V

CONCLUSION

The electrical conductivity (σ) of model liquid food system was determined and it was found that σ highly depended on temperature (T) and ingredients in the system, i.e. potato starch (St), salt (Sa), and sugar (Su) content but did not depend on voltage gradient and frequency. The correlated equation to predict the electrical conductivity of liquid food containing 2-8% potato starch, 0.5-1% salt and 2-12% sugar was:

$$\sigma = 0.379 + 0.871Sa - 0.0371St - 0.0298Su + 0.00164T + 0.0251SaT$$

The electrical conductivities of thermal-pretreated solid food were also not influenced by the voltage and frequency. For the mixture of solid-liquid food, the effective electrical conductivity (σ_{eff}) depended on the electrical conductivities of both phases and volume fraction. Increasing volume fraction of low conductive phase like vegetables gave a lower σ_{eff} while increasing the volume fraction of more conductive phase like surimi resulted in higher σ_{eff}. Using the circuit analogy concept, the effective electrical conductivities of solid-liquid mixtures between 0.2 and 0.6 volume fractions could be calculated from the electrical conductivities of individual components, volume fraction, and cross-sectional area and length of the ohmic cell. The calculated values agreed well with experimental values within ± 10% difference in most cases. High differences between the calculated and experimental values at high solid concentrations may be due to the arrangement of solid cubes within liquid that did not follow the assumption of particles resistance being in parallel with liquid. Therefore, this approach may not predict well in the system of very high solid fraction which was not often found in commercial practice.

During ohmic sterilization of solid-liquid mixtures of 0.2-0.6 volume fraction in static heater, the heating rate of the solid was about the same as the liquid even though the solid was less conductive than the liquid. At low volume fraction, the solid heated slightly slower than the liquid but solid tended to heat faster as the solid fraction increased. The model developed in this study based on the approach of entire mixture prediction by considering the small solid cubes uniformly distributed in the liquid like a homogeneous system. The effective electrical conductivity and average thermophysical properties were used to predict the temperature profile of the system. The model approximated experimental results well, both in explaining the experimental results and provided as a design tool to estimate the temperature distribution of the solid-liquid food mixture. It could describe the process as a basis for control.

Energy conversion from electrical energy input to thermal energy was considerably high (>90%) in sterilizing by ohmic heating, indicated high energy utilization due to direct energy utilization which was another advantage of ohmic heating.

SUGGESTIONS

As the model was highly simplified, it was necessary to use the accurate physical property data. However, data was unavailable and made it difficult to validate the model by using experimental results. Moreover, as food was varied in structures and properties, it was not possible to construct a general model prediction. More study is needed for food properties and natural variation of physical properties, in order to improve the model prediction. However, in order to ensure product and process safety, more complex model is necessary to study the local thermal and electric fields around individual parts of the system.